Academic careers : the effect of participation to post-doctoral program

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Abstract :

This paper is devoted to assessment of post-doctoral programs for young PhD awarded in French Universities. Using longitudinal from the French Ministry of Education, our question lead to the econometric evaluation of post-doctoral participation on the probability to obtain a job as researcher in the public sector of research. Based on the estimation of a conditional bivariate Probit model and computation of marginal effects, we demonstrate that going through a post-doctoral program increases of around 10% then chances to get an academic job. This result is reinforced by the effect of financial support, especially standard academic grant, which rises of more than 20% the probability to be recruited as researcher in the French public sector.

JEL classification :

Keywords : post-doctoral program, PhD graduated, bivariate Probit, marginal effects

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1. Introduction

The French academic system yield around 10 000 PhD per year, so that France is among the countries which have a huge number of young PhD. Comparatively, Europe has 68 000 new PhD each year and USA more than 40 000 (Nsf, 2002).

The organisation of research is a powerful factor structuring the labour market for recent doctorate recipients. One particular point relates to research jobs in academic systems. The queue for permanent research positions has created a specific labour market for young doctorates, characterised by a proliferation of post-doctoral programmes and fixed-term contracts financed by research contracts immediately after award of the doctorate. The recent evolution of the public policy for research induces the development of post-doctoral programs

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for PhD: in 2003, the National Center for Scientific Research (Cnrs) offered more than 400 post-doctoral grants, also in national labs which is an innovative orientation. In so doing, the public policy for research tends to institutionalise the participation to a post-doctoral program. Compound with a context in which job offers in the academic system become scarcer, the question of assessment of post-doctoral programs arises in an increasing way. This is the objective of this paper in which we will make use of longitudinal data on PhD graduates to assess the effect of post-doctorate for those who go through it. To our knowledge, this field of study was discussed little (See for the French labour market, Dedieu and Musselin, 2002 ;Martinelli and Molinari, 2000 or Recotillet, 2003b), undoubtedly because of scarcity of data on that topic (Recotillet, 2003a). Finally, the impact of a participation to a post-doctorate on the probability to obtain a job in the PSR (public sector for research) remains controversial. Using econometrical tools developed for the evaluation of programs, we propose a way to assess its effect for young French PhD graduated in 1996 in all field of education. They were surveyed in 1999 by the Cereq (French Ministry of Education).

From the econometrical point of view, the empirical assessment proposed here consists of identification of post-doctorate's effect which allows us to isolate the endogenous bias. The endogenous bias comes from the existence of unobservable individual characteristics which are correlated both in the probability to get a job in the PSR and the probability to go through a post-doctorate. Insofar as our two variables of interest are qualitative, the two step method developed by Heckman (1979) doesn't apply here. Consequently, the use of maximum likelihood implementation proves to be adequate but raises the complexity of the model (Wooldrige, 2002).
The estimation of two binary equations by maximum likelihood usually refers to a bivariate Probit. In our case, the assessment of post-doctorates consists of introducing the binary treatment variable in the job equation as Greene did in a different context (1998, 2000). Contrary to Greene (1998, 2000) for which the error terms of the both equations does not depart from zero, both of our equations are significantly correlated. As a result, computations of marginal effects, which are central in the estimation of this modelling, differ slightly. We also propose an estimation of these marginal effects what enables us to estimate the average effect of participation to a post-doctorate.

In the data set used, nearly 30% participated to a post-doctorate. For those who get through, the probability of being recruited in the PSR as researcher rises of 12%. This average effect hides a strong field of education's effect : whereas participation to a post-doctorate program for PhD graduated in exact sciences is a way to improve significantly the probability to enter the PSR, the result obtained is converse in human and social sciences.

The paper is organized as follows. Section 2 presents the econometric modelling, a conditional bivariate Probit. In the section 3, longitudinal data used are described and section 4 points out the main findings. Section 5 concludes.

2. Econometric modelling

Stating that going through a post-doctorate is, at least partially, correlated with getting a job in the public research sector, a suitable framework for modelling is necessary. A way to correctly proceed to the identification of the parameters is to define a statistical framework in which error terms of the two equations - participation to a post-doctorate and being employed in the PSR afterwards - are correlated. As the two dependant variables are discrete, the statistical framework could be a Bivariate Probit model, assuming that unobservable are normally distributed. In a linear case, the econometric modelling should be a SUR model.
Considering that the first equation estimates the probability to get an academic job in the PSR and that the second equation estimates the probability to participate to a post-doctorate training program, we have :

$$\begin{aligned} y^*_1 &= \beta'_1 x_1 + \varepsilon_1 \quad \text{if} \quad y^*_1 > 0,\ 0 \text{ otherwise} \\ y^*_2 &= \beta'_2 x_2 + \varepsilon_2 \quad \text{if} \quad y^*_2 > 0,\ 0 \text{ otherwise} \end{aligned} \qquad [1]$$

with x_1 and x_2 the two groups of regressors having common elements.
Assuming that the residuals follow a bivariate Normal distribution (0,0,1,1,ρ), we are in the framework of a bivariate probit model, with cumulative distribution and density function respectively $\Phi(x_1, x_2, \rho)$ and $\phi(x_1, x_2, \rho)$. The cumulative distribution function is the join probability that an individual participate to a post-doctorate and is recruited in the PSR, that is :

$$\Pr ob(Y_1 = y_{i1}, Y_2 = y_{i2}) = \Phi(w_{i1}, w_{i2}, \rho^*_i)$$

with $\rho^*_i = Q_{i1}Q_{i2}\rho$, $Q_{i1} = 2y_{i1} - 1$ and $Q_{i2} = 2y_{i2} - 1$, $w_{ij} = Q_{ij}\, z_{ij}$, $j = 1,2$

It follows that the log-likelihood function can be written as[1] :

$$\log L = \sum_{i=1}^{n} \Phi\left(w_{i1}, w_{i2}, \rho\right) \qquad [2]$$

From this specification, we are able to compute some marginal effects, which are of great interest in this paper.

In order to obtain marginal effects, we start by writing $x = x_1 \bigcup x_2$ and $\beta'_1 x_1 = \gamma'_1 x$. All the non zero parameters in β_1 are included in γ_1 and γ_2 is similarly defined. So that the bivariate probability distribution is the following :

$$\mathrm{Prob}\left[y_1 = 1, y_2 = 1\right] = \Phi\left[\gamma'_1 x, \gamma'_2 x, \rho\right] \qquad [3]$$

We can easily compute these probabilities for the other combinations of y items.
In that case, the marginal effect of x is given by :

$$\partial\Phi / \partial x = \gamma_1 g_1 + \gamma_2 g_2 \qquad [4]$$

with $g_1 = \Phi\left(w_{i1}\right) \cdot \Phi\left[w_{i1} - \rho^{*}_{i} w_{i1} \Big/ \sqrt{\left(1 - \rho^{2*}_{i}\right)}\right]$ and g_2 is constructed similarly.

At this stage of the modelling, we can compute the conditional mean $E\left(y_1 \middle| y_2 = 1, x\right)$. However, rather than pursuing in that way, we adopt here an alternative modelling, based on the introduction to the regressor vector of the variable "y_2" and on the estimation by maximum likelihood of the model. Then it allows to take into account all the combinations of the couple (y_1,y_2). In this particular case, which is our in that paper, we can write again [1] as following :

$$\begin{aligned} y^{*}_1 &= \beta'_1 x_1 + \alpha_1 y^{*}_2 + \varepsilon_1, \text{ if } y^{*}_1 > 0, 0 \text{ otherwise} \\ y^{*}_2 &= \beta'_2 x_2 + \varepsilon_2, \text{ if } y^{*}_2 > 0, 0 \text{ otherwise} \end{aligned} \qquad [5]$$

[1] the reader may report to Greene (2000 ;p.850) for the maximisation, especially, first and second order of the maximisation.

Under the same assumptions for the distribution of the residuals, if $\rho \neq 0$, estimation of the parameters in the first equation of [5] is not consistent.

The α_1 parameter here is assimilated to a treatment effect, that means, the effect of post-doctoral training on access to academic job. It follows that the mean effect of the treatment is equal to :

$$\Phi\left(\beta'_1 x_1 + \alpha_1\right) - \Phi\left(\beta'_1 x_1\right) \qquad [6]$$

Wooldridge (2002;p.478) points out that maximum likelihood estimator of this model is not trivial to implement and a correct two-step estimation would be consistent but less efficient.
A easier and more efficient estimator is obtained using a conditional bivariate probit model. In so doing, we can notice that :

$$\begin{aligned} \mathrm{Prob}\left(y_1 = 1, y_2 = 1\right) &= \mathrm{Prob}\left(y_1 = 1 / y_2 = 1\right) \cdot \mathrm{Prob}\left(y_2 = 1\right) \\ &= \Phi^* \left\{\mathrm{Prob}\left(y_1 = 1, y_2 = 1\right) / \mathrm{Prob}\left(y_2 = 1\right)\right\} \cdot \mathrm{Prob}\left(y_2 = 1\right) \end{aligned} \qquad [7]$$

with Φ* is the Normal bivariate distribution.

Rearranging the terms from [7], we then obtain a straightforward relation :

$$\mathrm{Prob}\left(y_1 = 1, y_2 = 1\right) = \Phi^* \left(\beta'_1 x_1 + \alpha_1, \beta'_2 x_2, \rho\right) \qquad [8]$$

The other alternatives for the couple (y_1,y_2) could be obtained likewise, so that we can simply write the likelihood function. This function might be maximised as in a bivariate standard model (Greene, 1998 ; Maddala, 1983).

However, a complete analysis of the model requires the computation of marginal effects. Given that,

$$\begin{aligned} E\left[y_1 \middle| x_1, x_2\right] &= \mathrm{Prob}\left[y_2 = 1\right] E\left[y_1 \middle| y_2 = 1, x_1, x_2\right] + \mathrm{Prob}\left[y_2 = 0\right] E\left[y_1 \middle| y_2 = 0, x_1, x_2\right] \\ &= \Phi^{*1}\left(\beta'_1 x_1 + \alpha_1, \beta'_2 x_2, \rho\right) + \Phi^{*2}\left(\beta'_1 x_1, -\beta'_2 x_2, -\rho\right) \end{aligned} \qquad [9]$$

Deriving [9] with respect to z, a variable that appears in x1 and/or x2, requires to derive the two following cumulative functions :

$$\begin{aligned}\partial\Phi^{*1}(\cdot)\Big/\partial z = &\left\{\phi(\beta'_1 x_1+\alpha_1)\,\Phi^*\left[\left(\beta_2 x_2-\rho(\beta'_1 x_1+\alpha_1)\right)\Big/(1-\rho^2)^{1/2}\right]\right\}\beta_{1z}\\ &+\left\{\phi(\beta'_2 x_2)\,\Phi^*\left[(\beta'_1 x_1+\alpha_1)-\rho(\beta_2 x_2)\Big/(1-\rho^2)^{1/2}\right]\right\}\beta_{2z}\end{aligned} \qquad [10]$$

The second derivative is the following :

$$\begin{aligned}\partial\Phi^{*2}(\cdot)\Big/\partial z = &\left\{\Phi(\beta'_1 x_1)\,\Phi^*\left[-(\beta'_2 x_2)+\rho(\beta'_1 x_1)\Big/(1-\rho^2)^{1/2}\right]\right\}\beta_{1z}\\ &+\left\{\Phi(-\beta'_2 x_2)\,\Phi^*\left[\beta'_1 x_1-\rho(\beta'_2 x_2)\Big/(1-\rho^2)^{1/2}\right]\right\}\beta_{2z}\end{aligned} \qquad [11]$$

Therefore, the effect of a variable z could be break up into a direct effect attributable to the presence of z in x_1 and an indirect effect due to its presence in x_2.

Direct effect

$$\left\{\begin{aligned}&\phi(\beta'_1 x_1+\alpha_1)\Phi*\left[\left(\beta'_2 x_2-\rho(\beta'_1 x_1+\alpha_1)\right)\Big/\left(1-\rho^2\right)^{1/2}\right]+\\ &\phi(\beta'_1 x_1)\Phi*\left[-\beta'_2 x_2-\rho(\beta'_1 x_1)\Big/\left(1-\rho^2\right)^{1/2}\right]\end{aligned}\right\}\beta_{1z} \qquad [12]$$

Indirect effect

$$\left\{\begin{aligned}&\phi(\beta'_2 x_2+\alpha_1)\Phi*\left[(\beta'_1 x_1+\alpha_1)-\rho(\beta'_2 x_2)\Big/\left(1-\rho^2\right)^{1/2}\right]+\\ &\phi(-\beta'_2 x_2)\Phi*\left[\beta'_1 x_1-\rho(\beta'_2 x_2)\Big/\left(1-\rho^2\right)^{1/2}\right]\end{aligned}\right\}\beta_{2z} \qquad [13]$$

In the case of a continuous variable z and ρ significantly different from zero, [18] and [19] can be directly used for computation. In the case of a discrete variable z which might appear in x_1 and/or x_2, we need to calculate the marginal effect from [9] as :

$$E\left[y_1 | x_1, x_2\right]_{z=1} - E\left[y_1 | x_1, x_2\right]_{z=0} \qquad [14]$$

Equation [14] is written as follows :

$$\begin{bmatrix}\Phi^*\left(\beta'_1 x_1+\alpha_1,\beta'_2 x_2,\rho\right)_{z=1}+\\ \Phi^*\left(\beta'_1 x_1,-\beta'_2 x_2,-\rho\right)_{z=0}\end{bmatrix}_{post-doc=1} - \begin{bmatrix}\Phi^*\left(\beta'_1 x_1+\alpha_1,\beta'_2 x_2,\rho\right)_{z=1}+\\ \Phi^*\left(\beta'_1 x_1,-\beta'_2 x_2,-\rho\right)_{z=0}\end{bmatrix}_{post-doc=0} \quad [15]$$

The difference between P1 and P2, given that $P1=\Phi^*(\beta'1x1+\alpha1,\beta'2x2,\rho)$ and $P2=\Phi^*(\beta'1x1+\alpha1,-\beta'2x2,-\rho)$, when the PhD participated to a post-doctorate is the indirect effect of the discrete variable z on y_1 through the post-doctorate variable. The difference between P3 and P4, given that $P3=\Phi^*(\beta'1x1+\alpha1,\beta'2x2,\rho)$ and $P4=\Phi^*(\beta'1x1+\alpha1,-\beta'2x2,-\rho)$ when the PhD did not participated to a post-doctorate might be understood as a direct effect on y_1 (Greene, 1998). Finally, the average effect of participation to post-doctorate is directly provided by [6].

3. Data

The outcome of participation to a post-doctoral program on probability to obtain a job in the PSR is examined by estimating the previous model for young PhD awarded during the year 1996 and surveyed in 1999 in France[2].

Table 1 – Proportion of post-doctorate, by fields of education

N=1744	% fields	% post-doctorate at least one time on 3 years	% post-doctorate at least one time on 3 years, except those still in post-doctoral position at the time of the survey
Mathematics, physics	16%	18%	20%
Mechanic, engineering sciences, computing	19%	11%	13%
Chemical	13%	18%	22%
Natural sciences	25%	45%	34%
Law, economics, management	13%	4%	6%
Human sciences	14%	4%	5%
Total	100%	27%	19%

[2] This longitudinal survey has been carried out by the Centre for Research on Qualifications (French Ministry of Education).

The sample -1744 young people- is nationally representative of French PhD awarded in 1996 in exact sciences, human and social sciences. Among the 1744 young PhD, 744 obtained a job in the public sector of research as researcher, nearly 45% of the sample. The main interest of this database is to provide information on participation to post-doctoral program, however, no information is available on the post-doctorate in itself. More than a quarter of young PhD had attended a post-doctoral program (about an half for natural and life sciences PhD, see table 1) and nearly 50% of them had a job in the public sector for research afterwards, a part which is similar to those who didn't attended (see Table 2).

Table 2 – Occupation 3 years after graduation

	Part of graduates employed in the public sector	Part of graduates employed in the public academic sector	Part of graduates employed in the private R&D sector
PhD graduates	61	50	16
PhD graduates in exact sciences	54	47	22
PhD graduates in human and social sciences	76	57	2
PhD graduates who completed an engineering schools	51	46	36
By field of education			
Mathematics and physical sciences	58	51	21
Mechanics, engineering sciences or computer science	50	42	25
Chemistry	40	34	31
Life sciences, geology	62	53	16
Economics, law and management sciences	63	50	4
Humanities	84	61	1

The improvement of working opportunities for higher education graduates has been followed by a significant job change, especially for young PhDs. The proportion of jobs in the public sector has declined, around 60% in 1999 (Table 2). At the same time, the proportion of higher education teachers and civil service researchers seems to be falling in the public sector (Béret, Giret and Recotillet, 2002), this means that these jobs account for only around 40% of all jobs (whereas it accounted more than half 4 years before). These two aspects are principally true for exact science PhDs, for which higher education teachers and researchers in the public sector account for 1 job in 3, while it is 1 in 2 for humanities and social sciences. The lesser part of academic careers has however not been balanced by a greater part of scientists in

R&D, even if they represent ¼ of the jobs held in exact science. This could be explained by the fact that since the beginning of the 90s, companies have employed less and less young PhDs to fill their researchers vacancies (Béret, 2000).

4. Main findings

Equation 1:determinants of participation to a post-doctorate

The estimations are reported in Table 5. They first show a strong effect of field of study, overlapping the effect of gender : PhD graduated in engineering sciences, law or economics, human sciences have a strong negative effect (they probably less enter a program), whereas PhD graduated in mathematics have a negative sign but lower. At the same time, graduated in chemical have the same probability to enter a program as those graduated in biology. This finding is not really surprising. Graduated in these field traditionally enter post-doctorate programs, mainly in Usa labs. In biology, nearly one in two graduated get a post-doctorate immediately after graduating (Martinelli, 2000 ; Beret, Giret and Recotillet., 2003). Behind an this disciplinary effect, we underline an institutional effect, that means : completing a PhD in a mixed unit of research (University and Cnrs) significantly enhances the probability of being enrolled in a post-doctorate compared to doctorates graduated at University. The institutional effect definitely recovers the role of networks in the PSR, developed by tenured researchers in labs from which PhD students benefit from.

Marginal effect of post-doctorate program

The marginal effect of participation to a post-doctoral program is positive on the probability to get a job in the public sector for research. The difference is estimated around 12%. Given that the mean duration of a post-doctoral program is nearly one year, the improvement of 12% of the probability to be recruited in the PSR requires to invest one year more in training for research. One could argue that the marginal effect is rather low comparatively to the investment required (moving abroad, high incentive to publish papers in a short time interval (see on this point see Dedieu and Musselin (2002)..). Furthermore, this positive effect may be counterbalanced by other individual dimensions such as field of education.

Marginal effects for variables included in the both equations

The marginal effects computed with the aid of [15] are presented in Table 3.

As we would have expected, the main result show a strong opposition between the two major field of education : exact sciences and human and social sciences. Behind this robust evidence, we highlight the existing differences in the quality of the thesis.

The values given by E1 designate that the participation to a post-doctoral program has a positive effect on the probability to get a job in the academic sector for those graduated in exact sciences, except in mechanics, engineering and computer sciences[3]. On the other side, the participation to a post-doctoral program has a negative effect for PhD graduated in human and social sciences. In other words, for PhD in exact sciences, post-doctoral programs may be assimilated to investments in human capital or to pre-requisites to become researcher in the public sector. The meaning is significantly different for those graduated in human and social sciences. Actually, the probability to get a job as researcher in the public sector decreases of nearly 10% had they participated to a post-doctoral program. For those graduates, participation to a post-doctoral program may represent a way to avoid unemployment more than a positive strategy.

Obviously, this evidence may be strongly linked to the nature and the quality of the post-doctoral program that it is in terms of quality depending on field of education, in terms of publications required at the end of the training or the existence of collaborations in a research project, as well as in terms of reputation of the laboratory in which the post-doctoral student is. As many elements that are missing in our set of observable and that are missing generally in statistical surveys (Recotillet, 2003). However one can point out that the heterogeneity of post-doctorate programs is certainly greater in human and social sciences than in exact sciences.

Table 3 – Marginal effects for regressors included in the both equations

	Z=1	***Z=0***	*Effect*	**Total effect**
Post-doc=1	**P1=$\Phi^*(\beta'1x1+\alpha1, \beta'2x2,\rho)$**	**P2=$\Phi^*(\beta'1x1+\alpha1, \beta'2x2,\rho)$**	E1=P1-P2	E1+E2
Male	0.1355	0.1320	0.0034	-0.0234
Mathematics	0.1564	0.1283	0.0281	-0.0141
Mechanics, engineering and computer science	0.0596	0.1446	-0.0850	-0.1811
Chemistry	0.1445	0.1311	0.0134	-0.1670

[3] This last result is not so surprising since PhD in mechanics, engineering or computer sciences find more often job opportunities in the private sector and have job profiles closed to engineers (Béret, Giret and Recotillet, 2002 ; Giret, Perret and Recotillet, 2003).

Law, economics, management	0.04024	0.1400	-0.0997	0.0236
humanities	0.04922	0.1389	-0.0895	0.0776
Post-doc=0	**P3=Φ*(β'1x1, -β'2x2,-ρ)**	**P4=Φ*(β'1x1, -β'2x2,-ρ)**	E2=P3-P4	
Male	0.3456	0.3697	-0.0271	
Mathematics	0.3179	0.3601	-0.0422	
Mechanics, engineering and computer science	0.2773	0.3732	-0.0958	
Chemistry	0.1927	0.3731	-0.1804	
Law, economics, management	0.458	0.3347	0.1232	
Humanities	0.4945	0.3275	0.1607	
Average effect of post-doctoral program : 0.12				

The E2 values confirm the previous evidence (Table 3). Probabilities to get an academic job decline significantly for PhD graduated in exact sciences had they not participated, whereas a non participation to a post-doctoral program induces a positive effect for PhD in human and social sciences. That means that in exact sciences, participation to a post-doctoral program, mainly for those in chemistry compared to those in biology, is the best strategy at the beginning of the career. We observe the exact reverse conclusion in human and social sciences, for which an increase of the probability to get researcher in the PSR means a non participation to a post-doctoral program.

Facing to these results, one can finally infer that the recruitment processes in the PSR are highly dissimilar in the two disciplinary fields.

We cannot ignore that the two strategies we highlighted and the job opportunities for young doctorates are sometimes rather radically divergent (Béret, Giret and Recotillet, 2003). This could be explained by the values of the total effect, E1+E2, which indicate that the higher probabilities to get an academic job are those of PhD in human and social sciences, whether they participated to a post-doctoral program or not. Job opportunities and wage offers in the private sector, mainly for those in mechanics, engineering science or computer science, could explain the lower value of jobs in the PSR. Then, a participation to a post-doctorate might be a signal to employers indicating they plan to remain in the PSR. In that special case, a post-doctorate could be assimilated to an human capital investment. However, the effect of participation to a post-doctorate on the wage earned in the private sector is not significant and rather reveals a anti-signal (Recotillet, 2003).

Marginal effects for variables included in the first equation

From Table 4 it appears that the financial support for doctorates has a strong effect on the probability to obtain a job in the PSR. More precisely, one should remain that in the French educational system, doctorates can apply for different sources of grants after completing their master degree. The most prestigious is granted by the Ministry of Research and is completed by teaching at the University; it is granted for 3 years and if the PhD is not completed the PhD student can then apply for a job as research assistant at the University. This pathway is probably the most efficient to obtain a job in the PSR and the estimation will help us to strengthen this widely spread assumption. We distinguish here the so-called academic pathway described previously from several other public or private grants: financial support from Ministry of Research solely, assistant of research at the University before the completion of the PhD, financial support from a public organization, employed on a research contract in a public lab, grant from a private company. Perret (2000) showed the pertinence of private financial support on getting a job in the private R-D sector. And even if the assumption is rather spread that there is a difference between PhD granted and those no granted, to our knowledge, no study investigated different type of public financial support on the probability to be recruited in the public sector.

Computations of marginal effect for variables included in the first equation settles the expected result on the effect of the nature of grants (Table 4). PhDs recruited as temporary assistant of research at the University (before the completion of their studies) are more likely able to be recruited in the PSR afterwards (+33%), had they participated to a post-doctorate or not. A similar result is applicable to the so-called prestigious academic pathway (financial support from the Ministry of Research and temporary assistant of research afterwards) since the probability to get an academic job increases of more than 20%. We notice here the very important effect of jobs as temporary assistant of research at University on transition from thesis to PSR may be due to the existence of a network inside the University system.

Table 4 – Marginal effects for variables included in the 1st equation

	Direct/Total effect
Financial support for doctorates	
Financial support from the Ministry of	0.215

Research and assistant of research afterwards	
Private financial support	-0.342
Financial support from public organization	-0.585
Employed on a research contract	-0.091
Temporary assistant of research[4]	0.331
Other financial support	-0.091
Without financial support	-0.220
Engineering school diploma	-0.092
Time to degree greater than 4 years	0.049
Time to degree lower than 3 years	-0.026

Other grants show negative direct effect on the probability to be employed as researcher in the PSR. A private financial support emphasize the specific pathway young PhD take when they carry out their PhD joining together a company and the University. However, the marginal effect is greater than those computed for those without financial support, for which the probability falls of 22%. Finally other form of public grants are not valued and even have negative impact on the probability to become researcher in the public sector.

Time to degree could be seen as an indicator of job experience and might then raises the probability to get an academic job. Conversely, the organization of public research restricts the access to public research (except University) at a certain age (31 years) and might imply a cut in the probability of interest. Nevertheless, marginal effects in Table 4 show a positive effect of time to degree greater than 4 years compared to those who completed between 3 and 4 years. Besides, the more the graduated is older, the less he enters a post-doctoral program (Table 5). Furthermore, PhD graduated 3 years or under enter with a lower probability into the PSR. We should remain that PhDs in human and social sciences are longer than those in exact sciences (Boulard and Mela, 2002) and that those in exact sciences have a lower probability to be recruited in the public sector. Moreover, the shortest time to degree are more likely due to graduated granted by private funding who enter the private sector afterwards. This result could be linked to the negative effect observed for doctorates having a engineer diploma, whom job opportunities are more frequently in the private sectors and especially in the R-D sector.

5. Conclusion

[4] In French, these jobs are called ATER (temporary assistant for teaching and research)

In this paper, the question of assessment of post-doctoral programs is highlighted. Whereas post-doctoral positions drastically expand for a while, it is of crucial economic interest to evaluate their impact on the probability that participants get a job in the public sector for research. In so doing, we start by assuming that post-doctoral programs prepare to academic careers on the French labour market.

This finally somewhat traditional question of evaluation leads to crucial econometric modelling. We implement here a conditional bivariate Probit model, already applied by Greene (1998, 2000) but on a different topic. However, whereas Greene empirical work is based on two equations which are not correlated, in our case, the equation of participation to a post-doctorate and to PSR are significantly correlated. We then have to refer to an accurate method of estimation and computations of marginal effects differ from Greene (1998).

The main result is a positive effect of post-doctoral program on the probability to get a job in the public sector for research however highly differentiated by field of education (exact sciences opposite to human and social sciences). Probabilities to get an academic job decline significantly for PhD graduated in exact sciences had they not participated, whereas a non participation to a post-doctoral program induces a positive effect for PhD in human and social sciences. That means that in exact sciences, attending a post-doctoral program, mainly in chemistry, is the recommended strategy to enter a career in the PSR. A reverse evidence is observed in human and social sciences, for which an increase of the probability to get researcher in the PSR suggests a non participation to a post-doctoral program. In that case, the best candidates are recruited after completion of the PhD and do not need to move abroad or in another French lab to go through a post-doctoral training.

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Appendix

Table 5 – Estimation of a bivariate conditional Probit

	Coeff.	Std.Err.	t-ratio	P-value
Post-doctoral program equation				
Constant term	0.922671	0.489807	1.88374	0.0595995
Male	0.063459	0.0788859	0.80444	0.421143
Field of education (ref: biology)				
Mathematics	-0.197522	0.115002	-1.71756	0.0858775
Mechanics,engineering or computer science	-0.580442	0.118046	-4.91709	8.78E-07
Chemistry	0.0256882	0.117166	0.219245	0.826459
Law,economics,management	-0.6958	0.141198	-4.92785	8.31E-07
Humanities	-0.688067	0.150282	-4.57852	4.68E-06
Place during the PhD (ref :University)				
National center for scientific research (Cnrs)	0.314963	0.103226	3.05121	0.00227919
Inserm, Inra	-0.0841742	0.164353	-0.512156	0.608542
Other lab	-0.0421208	0.119515	-0.352431	0.724515
Age at time of graduation	-0.0599418	0.0163597	-3.664	0.000248306
Job in the PSR equation				
Constant term	0.518303	0.534993	0.968803	0.332643
Male	-0.0303903	0.0676388	-0.449303	0.653213
Field of education (ref: biology)				
Mathematics	-0.195826	0.112367	-1.74273	0.0813802
Mechanics,engineering or computer science	-0.423529	0.129825	-3.26231	0.00110507
Chemistry	-0.455859	0.104297	-4.37077	1.24E-05
Law,economics,management	-0.149787	0.143654	-1.0427	0.297089
Humanities	0.0111523	0.133967	0.0832469	0.933655
Time to degree				
Time to degree greater than 4 years	-0.0611926	0.0776631	-0.787924	0.430741
Time to degree lower than 3 years	0.0083295	0.0833773	0.0999013	0.920423
Age at time of graduation	-0.00891553	0.0162986	-0.547011	0.584371
Financial support for PhD				
Financial support from Ministry of Research and temporary research assistant	0.351167	0.105681	3.32291	0.000890837
Private support	-0.910761	0.126441	-7.20303	5.89E-13
Financial support from a public organization	-0.200741	0.126127	-1.59158	0.11148
Employed on a research’s project	-0.185611	0.130659	-1.42058	0.15544
temporary research assistant at University	0.625812	0.130199	4.80658	1.54E-06
Other financial support	-0.391133	0.112398	-3.47989	0.000501611
Without financial support	-0.642057	0.144195	-4.45269	8.48E-06
PhD also graduated from engineering school	0.0219695	0.0970278	0.226425	0.820871
Number of unemployment spells	-0.528016	0.0583139	-9.05472	2.89E-15
Participation to a post doctorate program	1.08308	0.39605	2.7347	0.00624369
ρ (1,2)	-0.481097	0.236675	-2.03273	0.0420796